Alexandria Journal of Medicine (2016) 52, 367–370

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Alexandria Journal of Medicine

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The response of pre-inflammatory cytokines factors to different exercises (endurance, resistance, concurrent) in overweight men

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Received 28 November 2015; accepted 29 December 2015
Available online 23 January 2016

KEYWORDS

Systemic inflammation;
Training;
Overweight;
Cytokines

Abstract Applying several energy systems and concurrent performing of various training models have a more effective role in preventing precocious occurrence of many diseases compared to training single energy system. This can be seen in case of physiologic and metabolic adaptations of the human body too. The present study attempted to investigate the effect of endurance, resistance and concurrent (endurance–resistance) training on pre-inflammatory cytokines in overweight men. Accordingly, 43 healthy overweight (BMI = 28.56 ± 2.67) young (23.7 ± 3.3 yr) students were volunteered to participate and randomly divided into three experimental (n = 11) and one control (n = 10) groups. The experimental groups performed 3 days/wk endurance, resistance and concurrent training for 8 weeks. Also, prior to and after the training, a blood sample was collected from the subjects in order to measure pre-inflammatory cytokines (IL-1β, IL-6 and TNF-α). Following 8 week training, repeated measure ANOVA results showed a significant difference in IL-1β (P = 0.046) and IL-6 (P = 0.009) compared to baseline. However, this was not the case with the TNF-α. Furthermore, between group comparisons showed significant difference in IL-6 (P = 0.020) between endurance and resistance groups. Within group comparisons (depended t student test) also showed a significant difference in IL-1β and IL-6 of endurance and concurrent groups compared to baseline. Generally, it can be concluded that endurance and concurrent exercise training in part has a positive effect on pre-inflammatory cytokines.

1. Introduction

Inflammatory cytokines are soluble mediators that influence many inflammatory functions. These have an important role in pathology of many chronic diseases such as cardiovascular

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Peer review under responsibility of Alexandria University Faculty of Medicine.

http://dx.doi.org/10.1016/j.ajme.2015.12.007

disorders and type 2 diabetes mellitus.[1] The source of inflammatory cytokines interleukin 1 beta (IL-1β), interleukin-6 (IL-6), and tumor necrosis factor-alpha (TNF-α) can be muscle cells, adipocytes, brain, endothelial cells and many of other cells.[2] It's well known that adipose tissue could produce and release some cytokines such as leptin, TNF-α and IL-6. In fact, researchers believe that there is a close relationship between body fat mass and production of this cytokines.[3] In overweight individuals circulate indices of low-level inflammation are higher than normal weight people. It's likely that a part of mechanism of inflammatory indices reduction to be related to decrease in body fat mass.[4]

The effects of physical activity and exercise on systemic inflammation are a partly new topic devoted to researcher's tendency in recent decades. Furthermore, it's important to determine the best exercise training method in order to promote body inflammatory profile. Many people participate in various exercise training programs such as aerobic and resistance. Their aims can be from wining the competition as an athlete to health purpose such as physical performance promotion, body fat mass reduction and decreasing disease symptoms. But what's the best training method for reducing systemic inflammatory indices is the question to be answered.

Generally, some researchers had shown that exercise training can cause to promote inflammatory markers.[5] The effect of exercise training on systemic inflammation is controversy. Some studies have shown that exercise training can reduce inflammatory cytokines,[6,7] whereas other studies couldn't discover such results.[8,9] For example, effects of exercise training on IL-6 have been examined. After training program Donges et al defects significant changes in this cytokine,[10] but Nicklas et al. didn't see significant differences compared to before training.[11] Another study also had shown that 12 week walking program didn't changed inflammatory cytokines.[9] Then, to determine the effect of physical activity on inflammatory cytokines more studies well be done. There is no study about the effect of various training methods (endurance, resistance and concurrent) on inflammatory cytokines especially in overweight men. Then, the aim of present study was to determine the effect of endurance, resistance and concurrent (endurance–resistance) training on pre-inflammatory cytokines (IL-1β, IL-6 and TNF-α) in overweight men.

2. Material and method

2.1. Participants

Forty three overweight men (BMI = 28.56 ± 2.67 kg/m^2) student were volunteered to participate in the present study. They became fully aware from the study objectives, procedures and possible risks. Participants had not any regular training one year before study commences. They were randomly divided to endurance, resistance, and concurrent training groups (each n = 11) and a non-exercising control group (n = 10). Then, the Participants were homogeneous according to body mass index (BMI). Before training participants' characteristics are presented in Table 1. Moreover, according to the nutrition and calorie intake influences on systemic inflammatory markers, subjects' daily nutrition data were documented and analyzed via reminiscent questionnaire. Recommendation has been given to the subjects in case of remarkable differences in calorie intake. This study was registered (Medical Ethics Number 1010.90) and approved by the ethical review of the Medical Centre Board.

2.2. Physiologic measurements

Firstly, participants' characteristics were measured in a week prior to training program commencement. In the following day, their maximum oxygen consumption was measured using treadmill (TechnoGym, Italy) modified Bruce protocol. Body fat percent was indirectly measured using caliper (Laffayette, 01127 mod, USA) and Jackson–Pollock 3-point (abdomen, super iliac and triceps) method. Participants' one repeated maximum was measured for nine movements including bench press, biceps and triceps barbell curl, seated cable row, squat, leg press, leg extension, lying leg curl and decline crunch via the Brzycky method.[12] It should be noted that all the measurements were performed at 9–12 am.

2.3. Training program

The experimental groups accomplished an 8-week resistive weight training 3 sessions/wk. Control group only participated in daily activities. Briefly, endurance, resistance, and concurrent training groups performed a 5-min jogging as warm-up and finished daily training with range of motion (ROM) in order to cool down. Endurance training program includes aerobic running started with 45–50% of each subjects' heart rate reserve (HRR) for 20 min at the first week. In the last week, running time reached to 33 min at the intensity of 75–80% of subject's HRR. Training intensity and time were increased 5% each week for observance overload principle, except fifth week in which training was done in the same as fourth week. Polar instrument was used for heart rate monitoring. In order to control training program intensity polar monitors issued heart rate by producing signal during running. Resistance training program includes nine circuit resistance exercises which started with 50% of each subjects' 1RM at the first week. Resistance training group performed 3 set/session in which 8–12 rep/set in first three weeks, 10 rep/set in 4th and 5th weeks and 6–8 rep/set in last two weeks. 1–2 min and 3–5 min resting period was applied between exercises and sets, respectively. Weekly training intensity increased 5% of participants' 1RM in order to apply overload. For considering the probable strength improvement, participants' new 1RM record measured for all nine exercises in the fourth week and training protocol continued with these new percents of 1RM. Participants trained with 85% of their 1RM in the last training session. Concurrent training program includes accomplishing both endurance and resistance training programs in same severity and duration. This group trained 3 session endurance and resistance in two weeks alternatively.[13] All training sessions were performed on Sundays, Tuesdays, and Wednesdays at 5 pm.

2.4. Biochemical measurements

Two days prior to the training programs, the subjects attended hematology laboratory in Kurdistan University of medical sciences for a blood sampling. Laboratory technicians sampled 10 ml from left hand antecubital vein in fasting state (12 h).

Table 1 Characteristics of participants before training.

Variable	Endurance	Resistance	Concurrent	Control
Age (year)	24.6 ± 2.56	23.5 ± 3.21	22.9 ± 3.34	23.8 ± 4.11
Height (cm)	174.23 ± 6.51	173.78 ± 4.36	172.39 ± 7.11	174.63 ± 4.62
Weight (kg)	87.45 ± 3.57	88.42 ± 2.81	86.99 ± 4.81	85.02 ± 4.53
Body fat (%)	26.86 ± 2.84	27.35 ± 3.35	26.51 ± 6.12	28.85 ± 4.82
BMI (kg/m^2)	28.81 ± 2.65	29.28 ± 1.92	29.28 ± 2.17	27.88 ± 3.42
VO2max ($ml\ kg^{-1}\ min^{-1}$)	36.72 ± 4.04	35.37 ± 3.59	37.75 ± 2.94	36.41 ± 3.29

The data have been reported as mean ± SD.

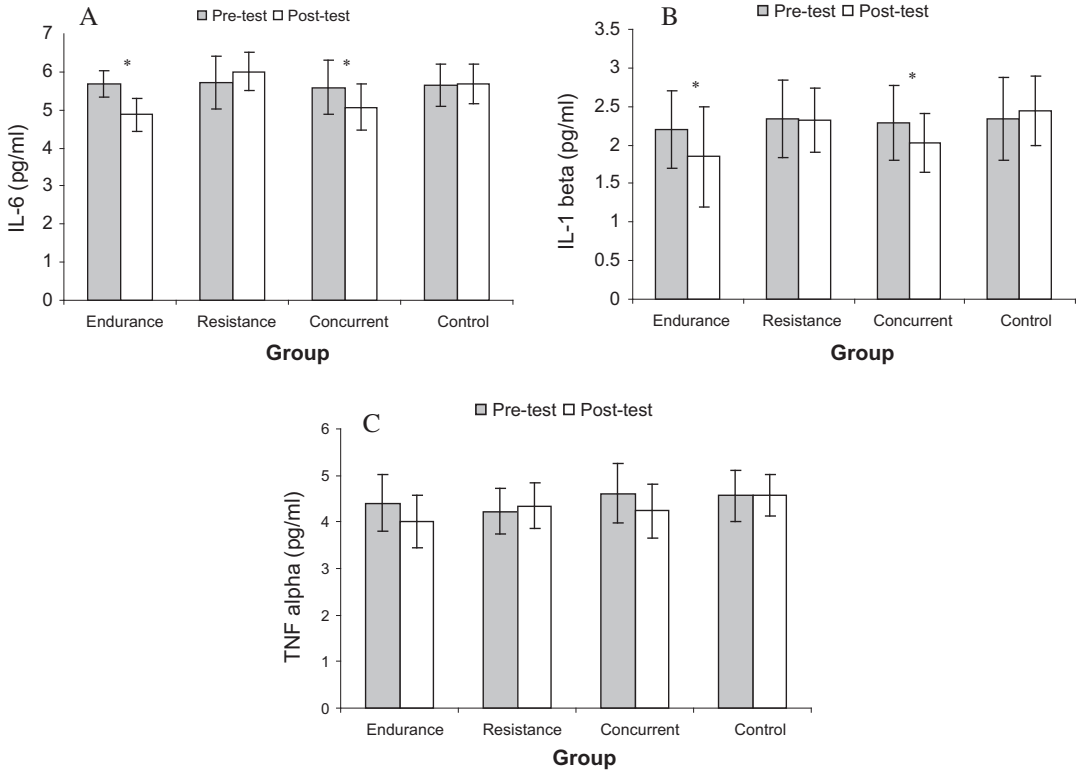

Figure 1 Pre- and post-training values in comparison of two groups in IL-6 (A), IL-1ß (B), TNF-α (C). *Discernible differences at $p < 0.05$.

Blood samples were collected into pre-chilled tubes, containing either EDTA or centrifuged at 2500–2700 rpm g at 4 °C for 10 min for plasma, serum and cell severance. After blood sampling and severance, serum and plasma samples were kept at −80° until analysis. The same procedure was followed 72 h after last training session. Besides, ELISA kits (Bender MedSystems, Norway) were used to measure interleukin-1 beta (IL-1β), interleukin-6 (IL-6) and tumor necroses factor-α (TNF-α). ELISA reader (Awareness, Technology, USA) was used to read ELISA kits.

3. Data analysis

The data are presented as mean ± SD. Descriptive statistics was used to calculate mean and standard deviation of descriptive variables. Normality of distribution was tested with Kolmogorov–Smirnov test. Leven's test was applied to survey the homogeneous variances of variable distribution. Data were analyzed for main effects using a two-way ANOVA for repeated measures. All data analyses were done via SPSS16 for windows and Microsoft Excel 2007.

4. Results

After training significant differences were found between groups only in case of IL-6 ($F = 3.670$, $P = 0.020$). Bonferroni Post Hog test showed that endurance training group had a higher significant difference with resistance training. In this case endurance group experienced the most reduction in serum IL-6 (−0.8 pg/ml). There wasn't a significant difference in case of IL-1β and TNF-α. Within group comparisons (by student t test) result was depicted in Fig. 1(A–C).

5. Discussion

Several studies were exerted close relationship between exercise and concentration of circulate cytokines. In human, it was shown that concentration of IL-1β, TNF-α, IL-6, IL-10 and INF-γ increased in response to acute exposure to exercise.[14–17] Some researchers found that inflammatory cytokines (e.g. IL-1β and TNF-α) doesn't increase with exercise, whereas they can cause to increase blood levels of anti-inflammatory and cytokine inhibitors such as IL-1ra, IL-10 and sTNF-R.[18] This fact shows that exercise is impressive of anti-inflammatory cytokine environment.

While having a close relationship with IL-1β and TNF-α, IL-6 isn't an inflammatory cytokine itself.[19] Starkie et al. had showed that IL-6 can inhibit endotoxemia due to increasing plasma concentration of TNF-α. Anti-inflammatory effects of IL-6 have been shown by studies in which IL-6 stimulates production of classic anti-inflammatory cytokines such as IL-1ra and IL-10.[20] However, exercise can cause to acute increase of IL-6 and release by exercising muscle, long time exercise training decreases circulate level of IL-6 and also by changing expression levels of receptors increases skeletal muscle sensitivity to this cytokine.[21,22]

Results of our study in case of unseen significant decrease in TNF-α, especially in endurance group, are the same as other foundlings.[23] No significant changes in IL-1, IL-6 and TNF-α after endurance training have been observed in untrained women. However, training type and participant of their study were not similar to our study. In the last of their study, they reported that 10 week resistance training with moderate to high intensity (1) reduces systemic inflammatory environment and (2) inhibits circulated IL-6 from exercising muscle in inactive women.[24] Same as our study, Ferriera et al. explained that circuit resistance training don't change serum concentrations of cytokines (IL-1β, IL6, IL8, IL10 and TNF-α).[8]

Finally, exercise training, especially endurance type training, can decrease some of inflammatory indices. Moreover, in this case endurance and somedeal concurrent training has more effects on systemic inflammation. Then, considering our study results its recommended for overweight people in order to promote inflammatory condition due to pre-inflammatory cytokines accomplish endurance training or combine their resistance training program with endurance training protocols.

Conflict of interest

Author states that there is no conflict of interest.

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